SECTION 15050

GENERAL MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.1 SCOPE

A. Work Specified In This Section
   1. This SECTION includes GENERAL MECHANICAL REQUIREMENTS applicable to the WORK.
   2. ELECTRICAL WORK, except as otherwise specified or indicated, shall be provided as part of WORK under Division 16 Sections.
   3. INSTRUMENT AND CONTROL WORK, except as otherwise specified or indicated, shall be provided as part of WORK under Division 13 Sections.
   4. Provide, as part of the WORK under Division 15 and referencing Sections, Electrical WORK necessary for the operation of a component, assembly, package or system, but which is not specified or indicated to be provided as part of the WORK under Division 16 Sections, in accordance with applicable provisions of Division 16 Sections.
   5. Provide, as part of the WORK under Division 15 Sections, Instrument and Control WORK necessary for the operation of a component, assembly or system but which is not specified or indicated to be provided as part of the WORK under Division 13 Sections, in accordance with applicable provisions of Division 13 Sections.

B. Coordination
   1. Process And Cleaning Fluid Waste Control
      a. All process fluids (chemicals), including flushing and cleaning solvents where specified, shall be coordinated, received, handled, stored, dispensed, utilized, and together with resultant waste, shall be disposed of in accordance with requirements of Owner's Representative's On-Site Chemical Management Function, who shall be, sufficiently in advance of the Work, advised of proposed activity, schedule, waste product concentrations and quantities, and as applicable, furnished with Materials and Safety Data Sheets for each product involved.
      b. Special care shall be exercised in handling/disposing of spills/wastes, to prevent injury to personnel, damage to facility/equipment, fire and pollution of environment.

C. Basic Electrical Requirements
   1. Electric power service shall be provided to factory assembled Division 15 and referenced Sections WORK, in accordance with the following, unless otherwise specified or indicated:
      a. Where "packaged" equipment or systems are specified, one or more power services may be required as part of the WORK under Division 16 Sections. Any required intercomponent or interassembly power, control, or instrument wiring for proper operation or functioning, shall be provided as part of the WORK under Division 15 Sections.

b. Where “packaged self-contained” equipment is specified, only one power supply will be provided as part of WORK under Division 16 Sections, except as otherwise modified or supplemented by the CONTRACT DOCUMENTS for that item. All other electrical equipment including disconnect switch, starters, and wiring shall be provided as part of WORK under Division 15 Sections.

2. Electrical WORK provided under Division 15 Sections shall conform to applicable UL, NEMA and NEC (ANSI/NFPA 70) Standards and Codes, and applicable material and installation requirements of Division 16 Sections.
3. Instrument and Control WORK provided under Division 15 Sections shall conform to the applicable material and installation requirements of Division 13 Sections.
4. Refer to ELECTRICAL and INSTRUMENT AND CONTROLS DRAWINGS and Divisions 13 and 16 Sections for specific provisions for and arrangement of interfacing components and circuits related to Division 15 Sections WORK.
5. For components/assemblies/systems provided with electrical requirements other than those specified, include as part of the WORK under Division 15 Sections, transformers, wiring, components and WORK necessary to the proper operation/functioning thereof.
6. Electrical ratings shall comply with ANSI/IEEE Std-141 and as follows:
   a. Electric power supply/service. 4160, 480 and 208 volts, 3 phase, 60 hertz (Hz) and 120 volts, 1-phase 60-hertz (Hz), hereinafter referred to as 4160 VAC, 480 VAC, 208 VAC and 120 VAC respectively.
   b. Electric motors. 4000, 460 and 208 volts, 3-phase, 60 hertz (Hz); 115 volt, 1-phase, 60 hertz (Hz), hereinafter referred to as 4000 VAC, 460 VAC, 208 VAC and 115 VAC respectively.
7. Provide wiring, which is external to electrical enclosures, within conduit, except where otherwise specified or indicated.
8. Coordinate the number of N.O. and N.C. and isolated contacts to be provided under Division 15 Sections to accommodate equipment/functions/interfaces specified or indicated by the CONTRACT DOCUMENTS.
9. Electrical testing of motors is specified as part of WORK under Division 16 Sections.

D. Related Work Specified In Other Sections
1. Division 01 Section “Summary of Work.”
2. Division 01 Section “Alteration Procedures.”
3. Division 01 Section “Shop Drawings, Product Data and Samples.”
4. Division 02 Section “Earthwork.”
5. Division 03 Section “Cast-In-Place Concrete.”
6. Division 09 Section “Painting.”
7. Division 13 Sections for Instruments and Controls, except as otherwise specified.
8. Division 16 Sections for Electrical Work, except as otherwise specified.

1.2 QUALITY ASSURANCE

A. General
1. Comply with the requirements of the GENERAL CONDITIONS and the SPECIAL CONDITIONS which form a part of the CONTRACT DOCUMENTS.

2. In the performance of the WORK, comply with the requirements of the CONTRACT DOCUMENTS and of the equipment manufacturer, whichever is the most stringent.
3. A deviation from SPECIFICATIONS which is not explicitly proposed/identified as a deviation, is subject to removal/replacement at any time after discovery and notification of the CONTRACTOR, at no additional cost to the OWNER.

B. Requirements Of Regulatory Agencies, Codes And Standards
1. Provide materials and equipment and execute the WORK, including tests and inspections, in compliance with the applicable provisions of the Federal, State and Local Government laws and ordinances and referenced codes and standards current, unless excepted, as of the issue date of this SPECIFICATION including applicable provisions of the Occupational Safety and Health Act (OSHA) and Environmental Protection Agency (EPA). Governing laws, ordinances, codes and standards constitute minimum requirements. All more stringent requirements of the CONTRACT DOCUMENTS shall modify, supplement and supersede applicable portions of governing laws, ordinances, codes and standards.

C. Referenced Specifications And Standards
1. The provisions of the REFERENCED SPECIFICATIONS AND STANDARDS, as applicable and referenced under Articles of this SECTION or other Division 15 Sections, govern the quality of materials, workmanship, and installation required under the CONTRACT.
2. AABC Associated Air Balance Council.
3. ABMA American Bearing Manufacturer's Association.
4. AISC American Institute of Steel Construction.
5. AISI American Iron and Steel Institute.
6. AMCA Air Moving and Conditioning Association.
7. ANSI American National Standards Institute.
8. ARI American Refrigeration Institute.
9. ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers.
10. ASCE American Society of Civil Engineers.
11. ASME American Society of Mechanical Engineers.
12. ASPE American Society of Plumbing Engineers.
13. ASTM American Society for Testing and Materials.
14. AWWA American Water Works Association.
15. AWS American Welding Society.
16. BOCA Building Officials and Code Administrators International.
17. CAGI Compressed Air and Gas Institute.
18. CISPI Cast Iron Soil Pipe Institute.
19. EPA Environmental Protection Agency
20. FM Factory Mutual Global.
21. FS Federal Specifications.
22. FDA Food and Drug Administration.
23. HI Hydraulic Institute.
24. IEEE Institute of Electrical and Electronics Engineers.
25. MSS Manufacturer's Standardization Society.
26. NBBPVI National Board of Boiler and Pressure Vessel Inspectors.

27. NFPA National Fire Protection Association.
28. NIA National Insulation Association.
29. OSHA Occupational Safety and Health Act.
30. SMACNA Sheet Metal and Air Conditioning Contractors National Association.
31. UL Underwriter's Laboratories.
32. Perform all welding, brazing, soldering and cutting work in conformance with requirements of CONTRACT DOCUMENTS and applicable provisions of the following:
    a. American National Standards (ANSI) B31.1 Power Piping with current Addenda.
    b. American National Standards (ANSI) B31.3 Process Piping with current Addenda.
    c. American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code, Section IX, latest edition, as amended by any Addenda.
    d. American Welding Society (AWS) D1.1, Structural Welding Code, latest revision.
    e. American Welding Society (AWS), Brazing and Soldering Manuals.

D. Source Quality Control
1. Perform manufacturer's standard and any special shop tests for each component to ensure compliance with intent of the SPECIFICATIONS.
2. Materials and equipment shall be the products of manufacturers regularly engaged in the manufacture of such products, shall essentially duplicate equipment that has been in satisfactory service at least 2 years prior to issue date of the CONTRACT and shall be supported by a service organization that is reasonably convenient to the site.

1.3 SUBMITTALS

A. General
1. Submit per Division 01 Section "Shop Drawings, Product Data and Samples," GENERAL CONDITIONS and as supplemented herein.
2. Review of shop drawings does not constitute approval of a proposed deviation from the CONTRACT DOCUMENTS which is not specifically noted and identified as a deviation in the shop drawings submitted for review.
3. Partial/piece-meal submittal of assemblies/systems is not acceptable and these will be returned without review.
4. Delays incurred due to disapproved submittals are the CONTRACTOR'S responsibility.

B. Proposal Data
1. Provide upon request, prior to award of CONTRACT, a MATERIALS AND EQUIPMENT SOURCE LIST for the proposed WORK.
2. Sub-Vendor Technical Services. Include in LUMP SUM PRICE, separately stated cost of technical assistance services of each authorized representatives of the various product manufacturers, during proposed materials/equipment assembly, installation, start-up, training of OWNER'S operating and maintenance personnel, debugging and acceptance testing. Include labor, materials, travel, per diem and any other costs as part of the "field engineer" work.
3. Exceptions to Specifications. Descriptively state and price each proposed exception or deviation, referenced to a specific paragraph, and attach to PROPOSAL. In the event that an exception involves a price change, provide cost as a VOLUNTARY ALTERNATE

PRICE. Unless specifically stated otherwise in PROPOSAL, the OWNER will assume that PROPOSAL is made without any deviation from "PLANS and SPECS" and CONTRACTOR shall be held responsible for every requirement thereof.

C. Materials And Equipment Source List
   1. Upon request and prior to placing orders for materials and equipment, submit for approval, a list of manufacturing sources from which the CONTRACTOR proposes to acquire materials and equipment to be incorporated into the WORK. Source approvals are tentative and are subject to approval of submittals/shop drawings verifying compliance with the CONTRACT DOCUMENTS.
   2. Specified manufacturers with or without model designation, shall be acceptable only where the manufacturer's product complies with or is modified as necessary to comply with specified and indicated requirements, and inclusion of a manufacturer's name as an acceptable product source does not void any specified criteria.
   3. Materials and equipment not specified or indicated as to manufacturer, but necessary for complete functioning systems, shall be provided from sources optional to the CONTRACTOR, but conforming to the quality levels and functional requirements for corresponding materials and equipment specified.

D. Submittals Procedures
   1. Furnish submittals for materials and equipment and elements of WORK, including *Samples [S]*, that are identified in Division 15 Sections by a different typeface and a bracketed code (e.g., *Item [P]*). Refer to Division 01 Section "Shop Drawings, Product Data and Samples" for definition of codes for types of submittals and the administrative requirements governing submittal procedure. Additional submittal requirements pertaining to the WORK are specified herein and in related Division 15 Sections.

E. Proof Of Compliance
   1. The UL Label or Listing with re-examination by UL and FM Label or Approved Product Listing will be accepted as evidence that the material or equipment conforms to certain minimums, but not necessarily to all specified requirements.

F. Samples
   1. Provide *samples or mock-ups [S]* where specified or indicated by (S).

G. Materials Safety Data Sheets (MSDS)
   1. Provide *OSHA Form 174 equivalent Materials Safety Data Sheets [P]* for all chemistry/solvent containing products proposed/furnished/used/handled. Distribute data in compliance with "right-to-know" regulations.
   2. Develop and maintain a data log for all chemicals/solvents/flushing wastes to be tracked/accounted for on a daily, weekly, and monthly basis, during construction, and deliver same to OWNER, together with certification of proper disposal, prior to final acceptance.

H. Shop Drawings And Product Data

1. Prior to fabrication or procurement of materials or equipment, submit certified shop drawings covering materials and equipment proposed under this CONTRACT. Shop drawings shall delineate any provisions for obtaining required performance under project service conditions. Submitted performance data shall be inherently certified to be applicable to intended project service conditions.
2. Submittals shall exclude data which is not pertinent to objective of submittal. Submitted items shall be identified as to intended use. Submittals which are not clearly identified as to pertinent constituents and intended use will not be reviewed, at CONTRACTOR'S risk of delay.
3. Shop drawings shall bear the CONTRACT DOCUMENTS Project Name, Architect-Engineers Project No., Addenda/Bulletin No., Item Name, Mark No. System or Point-Of-Use description, Drawing No., Specification Section, Article, and Page No.
4. Each shop drawing submittal shall bear mark-ups and certification of checking for completeness of submittal and compliance with CONTRACT DOCUMENTS by the CONTRACTOR'S ENGINEER, otherwise submittal will not be reviewed, at CONTRACTOR'S risk of delay.
5. Shop drawings for WORK specified to comply with criteria specified under Divisions 13 and 16 Sections shall be submitted in compliance with additional specific requirements specified thereunder.
6. Shop drawings submittals shall include required copies of. clearly delineated verifications of compliance with the elements of the CONTRACT DOCUMENTS, performance, details of configuration, construction, materials suitable for the service, support, functional ancillary provisions, utilities including power connections, wiring diagrams and sequence of operations, installation details for construction field conditions, other SECTION and other contract work interface data, etc.
7. Shop drawings shall include:
    a. CD or floppy electronic media.
    b. Software and Drawings hard copy.
    c. Piping and Instrumentation Diagrams.
    d. Sequences of Operation.
    e. Power and control panels, wiring.
    f. Control schematics.
    g. Electrical system and instruments/controls systems interfaces with external circuits which are part of WORK of this CONTRACT and other contracts.
    h. Piping systems including external systems interfaces which are part of the WORK of this CONTRACT and other contracts.
    i. System and equipment plans, elevations, arrangement drawings, selected views.
    j. System and equipment Sections, details.
    k. Product data shall include performance data and complete description of all equipment and components provided, including catalog cuts, bills of materials, illustrations and other descriptive data.
8. Submit integrated electrical drawings including power, control and instrument wiring interfacing with work under separate contracts for field work as well as factory assembled work. Manufacturer's electrical drawings are acceptable only when modified and supplemented to exactly reflect CONTRACT conditions. The "system" of drawings shall

include. overall schematic (elementary) diagram of the entire system of power circuitry detailing the number of and wire and conduit sizes, wiring diagrams showing the wiring layout of component assemblies or systems, interconnection wiring diagrams showing terminations of the interconnecting conductors between component assemblies, systems, control devices, remote monitoring/control functions, and control panels with interconnections, sequence of operation for components, assemblies or systems.

9. For programmable logic controllers (PLC'S) supplied, provide the following:
    a. Drawings indicating detailed input/output connections.
    b. Input/output lists describing function of each input and output and associated addresses.
    c. Complete wiring diagrams showing communication cable interconnections including. Central processor, I/O drives, power supplies, RS-232/other interfaces and all other required equipment.
10. Where software programs for programmable logic controllers are supplied, provide the following:
    a. Complete software documentation including analog input/output registers, timer/counter registers, internal coils used and all other information required to allow future software additions without disturbing resident programs.
    b. Commented and fully documented ladder diagrams of initial software programs.
    c. Three copies of program CD's with final, debugged programs. Supply CD's after complete, field testing of software programs and OWNER acceptance.
    d. Ladder diagrams complete with full documentation of final software programs which duplicate in hard copy the program tapes described in Item 3 above.
11. If construction conditions mandate deviations from CONTRACT DOCUMENTS, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted as "shop drawings" for approval.
12. Submit recommended Field Start-Up and Acceptance Testing Procedures specific to systems and conditions of this project, for OWNER evaluation/revision/concurrence.
13. On completion of the WORK, and prior to acceptance thereof, AutoCad drawings in CD format of the "as-built" Drawings shall be delivered to the OWNER per Division 01 Section "Project Record Documents."

I. Start-Up/Debugging Schedule/Checklist/Inspection
    1. Develop and submit, as a shop drawing, a Start-up Schedule and Check List which includes coordination of interfacing piping and wiring and inspection of interfacing work.

J. Operation And Maintenance Data
    1. Provide per Division 01 Section "Operating and Maintenance Data" and as supplemented herein.
    2. After start-up, issue the O & M Manual with addenda/revisions to all recipients of the O & M Manual within 10 working days following acceptance of the system.
    3. Manuals shall incorporate data to enable operators and maintenance personnel to understand the equipment, its potentialities, performance, limitations and maintenance needs. Data on design, construction, installation and operating features shall be included. Data submitted shall exclude or obliterate content which is not applicable to equipment purchased under the CONTRACT.

4. Manuals shall include the following:
    a. Software, hard copy (if applicable).
    b. P & ID, Drawings, Schematics Diagrams (See Shop Drawing requirements).
    c. System OEM (Original Equipment Manufacture) components and assembly drawings as built.
    d. Equipment brochures, data and catalog cuts including:
        1) Performance. Normal and abnormal conditions.
        2) Installation.
        3) Operation. Normal and abnormal conditions.
        4) Trouble-shooting.
        5) Safety precautions.
        6) Maintenance and repair.
        7) Nearest authorized OEM representative and stocking spare parts source.
        8) Pass-thru OEM materials and equipment guarantee/warranty.
        9) List OEM sources and recommended spare parts, unspecified but required special tool diagnostic equipment, and special consumables inventory, necessary for one year continuous operation. Include current cost price breakdown and normal delivery time for recommended inventory.

K. Tools/Keys
1. Provide complete set of special tools as required for field maintenance. Provide a locked tool box and four keys for each set of tools.
2. Provide four sets of keys to all lock equipped control enclosures.

L. Test Reports
1. Deliver test data required by the CONTRACT DOCUMENTS prior to final acceptance.
2. Test data shall include final set points of devices.
3. Detailed field test procedures, and where required factory test procedures, shall be submitted for approval at least 60 days before actual testing begins. Procedures used shall be bound with TEST REPORTS.

1.4 OPERATING AND MAINTENANCE PERSONNEL TRAINING

A. Provide concurrent with check-out, debugging and start-up, a coordinated training program oriented to needs of operating personnel and maintenance personnel, sufficiently prior to acceptance of the WORK, upon mutually satisfactory arrangement with the OWNER.

B. Submit detailed Training Program Schedule and topic outline encompassing CONTRACTOR furnished systems, for approval by the OWNER.

C. Provide one copy of digital video disc (DVD) recording of instructions for OWNER'S use.

D. Provide a total of not less than specified or approved "class room" and all necessary "field" hours, in addition to requirements specified elsewhere, encompassing mechanical, electrical, chemical, pollution and safety aspects, sufficient for personnel to operate and maintain systems and consistently achieve specified objectives.

E. Product, systems technicians, start-up engineers, complemented by instrument engineers, supplemented by CONTRACTOR'S staff, shall comprise the training staff.

F. Training materials shall include samples, shop drawings, operating and maintenance manuals, demonstrations, specified reports/data, installed and functioning systems, and the like.

1.5 PROJECT CONDITIONS

A. Sequencing
   1. Make all connections to existing systems during designated periods, upon written approval of OWNER and at no increase in the CONTRACT Sum.
   2. Coordinate/ schedule sufficiently early delivery of equipment and subsequent installation WORK with interfacing WORK for required access, subsequent structural work, drainage provisions, external systems connections, concrete work and the like.
   3. Skid-mounted equipment shall be modular/sectionalized with alignment pins, as indicated or necessary, to pass through restricting access provisions, vertically or horizontally (if so designed) without field disassembly. Any disassembly and reassembly of equipment systems for access purposes shall be at no additional cost to OWNER.
   4. Provide equipment access including ladders to vessel manholes and locate access doors/manholes to accommodate indicated installation access provisions/constraints with maximum safety and convenience for OWNER'S personnel. Verify access orientation with General Arrangement Drawings before release of equipment/vessels for fabrication.

B. Existing Facilities
   1. Do not interrupt existing utilities, except as specified or when approved in writing, and then only after temporary utility services have been approved and provided. INTERRUPTIONS must be scheduled to suit OWNER requirements.
   2. Verify conditions and constraints of existing work. Where existing connections require modification in order to match or connect work under this CONTRACT, provide all necessary labor, materials, and equipment to accomplish the WORK. In addition, maintain integrity of the existing systems. Rectify any contamination, degradation of cleanliness or damage to the existing systems to the satisfaction of the OWNER. Provide all WORK so required at no increase in the CONTRACT Sum.

C. Removal Of Mechanical Equipment And Fixtures
   1. Disconnect mechanical work to be removed at the nearest convenient connection to existing services which are to remain. Disconnect the mechanical equipment and fixtures at fittings or header valves and plug or cap. Do not remove such equipment until approved by the OWNER.
   2. All materials and equipment which are removed, except for those items indicated to be relocated or delivered to OWNER storage or directed to be relocated or delivered to OWNER storage by the OWNER, shall become the property of the CONTRACTOR and shall be promptly removed from the site.

D. Asbestos Removal/Remediation Work
   1. Asbestos removal and remediation Work shall be done under separate Contracts.

E. Housekeeping/Safeguarding Construction
   1. Perform operations during construction and upon completion of the WORK of this CONTRACT in accordance with the applicable requirements of NFPA Standard No. 241 and the CONTRACT DOCUMENTS.

F. Trades Interference
   1. Space and elevation occupancy and sequence of occupancy shall be scheduled/coordinated or resolved, by the CONTRACTOR, to preclude any codes, trades or structures interferences between present and future WORK by this CONTRACTOR and other CONTRACTORS working in the area, at no additional cost to the OWNER.
   2. Coordinate underground piping, conduits, cables and substructures and aboveground piping, wiring, lighting fixtures, mechanical/electrical, ducting, building equipment, process equipment, control panels, and other construction, to facilitate the installation of this WORK and compliance with applicable codes.

1.6 GUARANTEE/WARRANTY

A. The guarantee shall comply with requirements of General Conditions, except where supplemented or superseded by specific requirements of Divisions 15 and 13 Sections.

B. For heating, ventilating and air conditioning systems, the minimum guarantee period shall be extended to include one complete heating season and one complete cooling season after final acceptance.

C. Pass through to OWNER, all OEM materials, equipment and performance guarantee/warranty and bind copies thereof in Maintenance Manuals.

D. The guarantee shall warrant that the WORK and execution thereof i.e. workmanship, materials, equipment and systems, and performance thereof, shall meet the specified/indicated requirements, for the specified period after final acceptance or if deficient, shall be reworked or replaced promptly, to meet requirements of the CONTRACT DOCUMENTS, at no additional cost to the OWNER.

E. Subsequent to final acceptance, the OWNER reserves the option to request performance tests throughout the guarantee period, in accordance with the requirements of the Article entitled, “FIELD TESTS DURING GUARANTEE PERIOD”.

1.7 PRODUCT INSPECTION, DELIVERY, STORAGE, HANDLING

A. Materials/Equipment Inspection
   1. The OWNER’S REPRESENTATIVES shall be granted the right to inspect and be present at the factory, upon any reasonable occasion, during the manufacture, assembly and pre-shipment shop testing, operation/simulation for all equipment covered by this CONTRACT.
   2. Provide OWNER with written notice two weeks prior to schedule date for conducting all tests required by the CONTRACT DOCUMENTS.

3. All material and equipment, workmanship and performance thereof, shall be subjected to inspection and test after its delivery to the site. In case any articles are found to be defective in material or workmanship or otherwise not in conformity with the SPECIFICATION requirements, OWNER shall have the right to reject such articles or require their correction.
4. Rejected WORK requiring correction shall be removed by and at the expense of the CONTRACTOR. Promptly remove such WORK and proceed with the replacement and/or correction thereof, since the OWNER may contract for or otherwise replace and/or correct such WORK, and charge to the CONTRACTOR, the excess cost occasioned the OWNER.

B. Shipping/Storage/Handling
1. Protect materials and equipment, including surface finish, against detrimental conditions within CONTRACTOR'S control, including freezing and corrosion, during transport, storage, receipt, erection, connection, and until acceptance within OWNER'S adequately environmentally controlled space.
2. Match mark disassembled components. Close and seal open ends and maintain so until connection, in compliance with specified cleanliness requirements. Modularize, reinforce, brace, pack for shipment and handling per applicable commerce requirements and for handling within constraints of site destination available access.
3. When storing equipment off-site, keep in dry, protected, environmentally controlled space, at a temperature range of 40 to 90 degF, humidity range to prevent condensation, packaged/sealed to prevent incursion of detrimental particulate.
4. Nitrogen blanket, desiccant protection and shrink-wrapping is suggested where applicable.
5. The OWNER shall be informed of the fact when equipment will be stored off-site.

PART 2 PRODUCTS

2.1 GENERAL

A. The CONTRACT DOCUMENTS define process concepts, materials and equipment, systems duty, capacity, operating conditions and product requirements, setting forth minimum requirements and details which will assist the BIDDER in the preparation of his Proposal and the successful CONTRACTOR in assuming responsibility for the whole WORK.

B. These minimum requirements and details shall not be construed as relieving the CONTRACTOR from providing all WORK in accordance with the necessary expertise and capacity, even though some items of WORK may not be complete or specifically mentioned or indicated, to suit the needs of the required WORK.

C. Where any project condition would adversely affect the continuous service performance or capability of indicated products, de-rate, modify, or propose replacement of the product, as necessary to obtain continuous service performance required by the CONTRACT DOCUMENTS.

2.2 LUBRICANTS

A. Obtain from manufacturer's Operating and Maintenance Manuals, types and sources of lubricants necessary to start-up, test and operate equipment installed under this CONTRACT.

B. Provide, where not furnished by OEM, lubricants of required quality/characteristics in sufficient quantity for start-up test and operation, until OWNER acceptance, and for a period not less than six months thereafter.

C. Record type, amount of lubricant used for each machine. Bind all data developed in Operating and Maintenance Manuals in Lubrication Section.

2.3 CLEANING AND WASTE SOLVENT AND PROCESS FLUID INVENTORY

A. Provide OWNER approved virgin or reclaimed cleaning solvent which is safe and non--reactive with containment materials and process fluids.

B. Waste cleaning solvent inventory and aggregate waste flushing process fluid, apportioned by process fluid system storage/pipe size/length, shall be disposed of to an OWNER selected and approved, EPA licensed/authorized/approved waste reclaim/disposal facility. The CONTRACTOR shall provide OWNER with a legal "paper trail" documentation of proper disposal before final payment.

2.4 INDUSTRIAL AC ELECTRIC MOTORS

A. General
   1. *'T' frame motors [D,P]:* Manufactured in the U.S.A. per applicable provisions of NEMA MG-1 and requirements specified herein. Manufacturer's standard special purpose motors may be provided where so specified or approved by the ARCHITECT-ENGINEER.
   2. *High efficiency motors [D,P]:* Manufactured in the U.S.A. per NEMA MG1, or, and the requirements specified herein.
      a. General Electric.
      b. Magnetek.
      c. Reliance
      d. U.S. Motors.

B. Service Requirements
   1. Duty requirements include:
      a. A motor minimum service factor of 1.10 with sizing at loads imposed by normal service operation of equipment to preclude brake horsepower requirements in excess of 100% of the nameplate horsepower.
      b. Sufficient torque to accelerate connected load to full rated speed within 20 seconds with 80% of rated voltage maintained at motor terminals during the starting period.
      c. Suitability for across-the-line, full-voltage starting.
      d. Suitability of insulation class for duty ambients.
      e. Suitability of enclosures for space atmosphere.

2. Furnish motors with frame dimensions and with shaft height and size suitable for the torque and speed ratings of the motor.
3. Motors under 1/2 horsepower. 115 volts single-phase, 60 hertz, permanent, split capacitor-start-induction run squirrel cage type, unless otherwise approved.
4. Motors 1/2 horsepower and over. 460 volts, 3 phase, 60 hertz, squirrel cage induction type, NEMA B, unless otherwise specified.
5. Two speed motors shall be two winding type.
6. Integral horsepower motor noise level per NEMA MG-1, Section 12.49, listed values.
7. Motors driven by electronic variable speed drives shall meet the requirements of NEMA MG1, Part 31, Definite Purpose Inverter-Fed Motors.

C. Construction
1. Furnish enclosures of ferrous materials with cast ferrous end bells. Furnish foot-mounted type motors, except as otherwise specified. Motor windings shall be copper.
2. For bearings in single phase motors, use prelubricated, seal-cartridge, manufacturer's standard anti-friction type.
3. For bearings in polyphase motors, use double-shielded, heavy duty ball or roller anti-friction type of U.S.A. manufacture with adequate provision for thrust imposed by equipment duty load. Construct bearings of degassed, vacuum processed alloy steel. Rate bearings for ISO 281 L-10 Minimum Rating Life for 30,000 hours at rated motor speed. Include lubrication fittings and relief to outside of housing for each bearing and make provisions for relubrication while operating.
4. Furnish grease lubricant selected for compatibility with duty ambients.
5. Provide integral horsepower motors with mechanically attached manufacturer's standard stainless steel nameplate containing ABMA bearing numbers.
6. Furnish open-dripproof enclosure, except as otherwise specified or indicated.
7. Furnish totally enclosed nonventilated or fan cooled enclosure where located in an airstream or where specified or indicated. Fit enclosures with drain plugs in catalogued available sizes.

2.5 MISCELLANEOUS MATERIALS

A. Equipment Grout
1. TYPE EP Water/Chemical/Oil Resistant Epoxy Grout: Premixed, nonshrink grout, consisting of plastic resins base, with appropriate modifiers:
   a. Euclid Chemical Co.
   b. Master Builders
   c. Five Star Products Inc.
   d. Blome Cements Co.
   e. Sika Corp.
   f. Sauereisen Cements Co.

B. Steel Primer Coatings
1. TYPE A: Polyamide blend high-build epoxy or urethane for manufacturer required substrate.
   a. Ameron "Amerlock 400"

b. Carboline “Carbomastic 15 or Low Temp 242”

2. TYPE B: Inorganic zinc rich coating per MIL-P-23236, Type I, Class 3 for manufacturer required substrate.
   a. Ameron, “Dimetcote”.
   b. Carboline Carbo-Zinc No. 11.
   c. Tnemec 92 zinc.

PART 3 EXECUTION

3.1 GENERAL

A. Execute the WORK, in accordance with the CONTRACT DOCUMENTS, to provide the OWNER with first class materials, equipment, state-of-the-art workmanship and expertise and appearance/finish, subject to the closest inspection by the CONTRACTOR, whether or not the OWNER or authorities having jurisdiction, perform any part of the inspection.

B. Execute the WORK in accordance with requirements of referenced codes, standards and regulations, the CONTRACTOR’S proffered experience in building specified systems, requirements of authorities having jurisdiction and where specified, in accordance with submitted and approved procedures.

C. Perform the WORK and provide required expertise, in accordance with manufacturer’s published and written project specific instructions, and where necessary for proper execution of the WORK or where specified, under the specific direction of a competent authorized technical representative of the manufacturer.

D. Materials and equipment furnished, and WORK done, shall be subject to inspection by the OWNER and authorities having jurisdiction. Such inspection shall not relieve the CONTRACTOR’S responsibility for furnishing qualified labor and material in strict accordance with these SPECIFICATIONS.

E. Materials and equipment not meeting specified requirements shall be rejected and replaced at once with materials or equipment of the specified type and quality, at no additional cost to the OWNER.

F. Systems shall be complete in all details, interfaces and ancillaries necessary to the specified WORK, and even though not all items of WORK necessary thereto are specifically mentioned by the CONTRACT DOCUMENTS, they shall be provided.

G. Provide, subject to OWNER’S approval, all modifications to ancillary facilities required by the proposed equipment, at no increase in CONTRACT Sum.

H. During construction and testing procedures, maintain integrity of existing structures.

I. Provide for and fit materials and equipment into available installation, maintenance access/clearance space indicated; otherwise, notify the Owner in advance of the WORK.

J. Provide, maintain and enforce safety and environmental protection provisions necessary to the Work, including OSHA "Lockout/Tagout" provisions, during construction/testing and for Owner's subsequent use, whether or not delineated on the Drawings. Include "Lockout/Tagout" specific shop drawings.

K. Refer to referenced SOURCES for applicable requirements which are modified or supplemented herein.

L. No changes or deviations from this SPECIFICATION shall be permitted without prior written approval and credit to OWNER where due.

M. It is incumbent upon the CONTRACTOR to ensure OWNER'S REPRESENTATIVE witnessing and inspection of WORK before closure.

3.2 CURBS AND HOUSEKEEPING PADS

A. Provide, as part of WORK under applicable Division 15 Sections, unless indicated otherwise, 4-inch high, cast-in-place (scarified/pinned/epoxy bonded) concrete curbs at all locations where piping/ducting not in sleeves penetrate aboveground concrete floors.

B. Provide, upon approval of equipment shop drawings and as part of WORK under applicable Division 15 Sections, unless indicated otherwise, cast-in-place (scarified/pinned/epoxy bonded) concrete "Housekeeping Pads" not less than 4 inches high or 6 inches high where indicated on DRAWINGS, and extending a minimum of 6 inches beyond the equipment mounted thereon.

C. Supply anchor bolt and sleeve assemblies for all concrete equipment bases required in connection with the work under this CONTRACT. Anchor bolts and sleeves shall be of approved material, size and shape. Inside diameter of sleeves shall be not less than 2-1/2 times the bolt diameter.

D. CONTRACTOR shall be responsible for providing an accurate drawing of each equipment base required with the location of each anchor bolt properly dimensioned, and check and approve the formwork and placement of the anchor bolts, prior to placement of concrete.

E. After setting and leveling the equipment, provide specified non-shrink grout for each base with minimum 1 inch nominal and maximum 2" thickness between the top of the concrete base and the bottom of the equipment base. Leveling of equipment and grouting shall be in strict accordance with manufacturer's recommendations and Millwright Trades requirements.

F. Apply two coats of polyamide epoxy for a total DFT of 6 mils. Color shall be grey, unless otherwise selected by OWNER'S REPRESENTATIVE. Refer to Division 09 Sections "Painting" and "Painting Materials" for materials and application.
   1. Ameron "Amercoat 66".
   2. Carboline No. 191
   3. Sherwin Williams
   4. Tnemec

G. Perform WORK in accordance with applicable requirements/details of the STRUCTURAL DRAWINGS and Division 03 Section "Cast-In-Place Concrete."

3.3 INSTALLATION AND APPLICATION INSTRUCTIONS

A. General
   1. Furnish, apply, install, adjust, test and operate all materials, equipment and systems in conformance with the approved/certified shop drawings and manufacturer's published instructions, except as more stringently modified and supplemented by the CONTRACT DOCUMENTS. In the event of conflict between manufacturer's specific criteria and the CONTRACT DOCUMENTS, bring such conditions to the ARCHITECT-ENGINEER'S attention for resolution, to result in construction best suited to project conditions.
   2. The procedures and means employed for doing the various classes of WORK shall be at the option of the CONTRACTOR, subject to the CONTRACT DOCUMENTS, to provide the OWNER with first-class materials, workmanship, and acceptable appearance/finish, subject to the closest inspection by the CONTRACTOR himself, whether or not the OWNER'S REPRESENTATIVE performs any part of the inspection.

B. Installation
   1. Unload, receive, store, relocate, handle, uncrate, inspect, check, clean, assemble, rig, install, test and adjust all materials and equipment, each in its proper location with constraints as indicated or specified herein, complete with ancillary items, in satisfactory operation condition.
   2. Set equipment to accurate line and grade, leveling equipment as required with metallic shims or filler plates.
   3. Provide grouting; aligning equipment components. anchor bolts; drilling dowel holes and doweling equipment bases; vibration isolation.
   4. Cut shims from shim-stock, sheet or plate steel or corrosion resistant metal sized for full bearing surfaces. Remove shims after grouting if so required by the manufacturer.
   5. Provide field balancing.
   6. Maintain tolerances in leveling, alignment and vibration and other specific installation requirements for each class of WORK in accordance with manufacturer's published installation instructions, unless otherwise specified.
   7. Provide epoxy grout where specified and where grout is exposed to corrodent/oil exposed service, otherwise provide premixed, non-shrink grout, mixed and applied in accordance with the manufacturer's recommendation. Grout shall be complete, continuous and free from voids.
   8. Furnish and position anchor bolts per approved/certified shop drawings, except as otherwise indicated. Locate per approved/certified shop drawings, underfloor conduit, drain lines and hub-outlets within or directly adjacent to equipment base and as closely as possible to equipment connections.

C. Thermal Metal Joining And Cutting
   1. Each party performing thermal metal joining and cutting shall be responsible for the quality of WORK done by his organization and shall repair/replace, in accordance with

specified requirements, any WORK not performed in accordance with these SPECIFICATIONS.

2. All welding, brazing, soldering, and cutting work shall conform to the following codes and supplementary requirements.
    a. ASME Boiler and Pressure Vessel Code (BPVC) and Addenda, Section I, VIII and IX as applicable.
    b. ASME/ANSI B31.1 Power Piping Code and Addenda.
    c. ASME/ANSI B31.3 Process Piping Code and Addenda
    d. AWS D1.1 Structural Welding Code and Addenda.
    e. AWS Brazing Handbook.
    f. ASTM B 828 Standard Practice for Making Capillary joints by Soldering of Copper and Copper Alloy Tube and Fittings.
    g. CDA Copper Development Association Guide Specification for Copper and Copper Alloy Building Piping Systems.
    h. State/Local Codes.
3. Orbital welding is acceptable in all pipe sizes, shall be code compliant when executed by operators in accordance with manufacturer's instructions. Orbital welder operators shall be qualified on-site by manufacturer/CONTRACTOR, in presence of OWNER'S REPRESENTATIVE.
4. Welders and welding procedures employed on tanks, pressure vessels and pressure piping and specified work, shall be qualified per ASME/BPVC Section IX. Provide for each project material/joining method, a Welding Procedure Specification QW-842 (WPS), a corresponding Procedure Qualification Record QW-843 (PQR) and for personnel currently qualified to execute each WPS, a Welder or Welding Operator Qualification Test QW-844 (WOQ). WPS and PQR established by National Certified Pipe Welding Bureau (NCPWB), Hartford Steam Boiler Insurance Inspection (HSBII) and the like are acceptable. For each WPS employ personnel with current WOQ experience as defined by ASME/NCPWB/HSBII. Where a WOQ is more than three years old, the welder shall be re-qualified; where the welder has not been employed on applicable WOQ within the past three months, requalification is also required. File for record, each applicable WPS/PQR/WOQ.
5. Where specified, comply with OWNER-furnished WPS, PQR requirements and perform WOQ in the presence of OWNER'S REPRESENTATIVE.
6. Perform torch brazing of copper and alloys per NCPWB WPS 107.10/107.12, unless otherwise approved.
7. Perform soft soldering of copper and alloys per ASTM B 828 and CDA Guide Specification, unless otherwise approved.

3.4 BUILDING AND OTHER SURFACE PENETRATIONS

A. General
    1. Provide all openings and sleeves required for this Work in cooperation with the WORK under other SECTIONS, as indicated on the DRAWINGS.
    2. Surface penetrations shall be as described below and in conformance with applicable code requirements:
        a. Smoke proof/smoke rated where penetration of a smoke barrier occurs.

b. Fire proof/fire rated where penetration of a fire barrier occurs.
c. Watertight below grade.
d. Weathertight above grade.
e. Gas and vapor tight to preclude gas or vapor entry into conditioned or occupied spaces.
f. Sound-tight wherever necessary to preclude sound transmission to or between occupied spaces.
g. Vibration isolated from penetrated structure.
h. Toxic or deleterious-substance-tight where necessary to protect space content or occupant.
i. Explosion-proof where flammable liquids are stored or where flammable vapors are generated or where flammable gases may accumulate.

3. Utilize indicated openings and if necessary, upon prior approval, modify equipment or other work to suit, at no increase in CONTRACT Sum. In the event that indicated openings cannot be utilized, revise indicated openings or, if necessary, close indicated openings and provide new openings, all as part of the work of this CONTRACT, at no increase in CONTRACT Sum. Advise the ARCHITECT-ENGINEER of the need for revision of indicated openings, closure of indicated openings or replacement-new openings prior to award of CONTRACT so that a design can be made. After award of CONTRACT, costs related to design and shop drawing approval of indicated opening revision and closure and replacement-new openings shall be borne by the CONTRACTOR.
4. Provide all calking, flashings and counterflashings required to maintain integrity of sanitation and weather protection at all mechanical systems penetrations of building boundary surfaces.
5. Building surface penetrations and finish and execution thereof shall be by personnel skilled in the Work, compatible with specified function and contiguous surfaces and acceptable to the ARCHITECT-ENGINEER.

B. Cutting
1. To avoid unnecessary after-the-fact cutting of building surfaces. Provide all support inserts, sleeves, anchors, footings, foundations, chases, openings, drainage provisions and the like during construction, in sufficient time for appropriate trades to accommodate these items in the normal course of construction.
2. Do not cut, burn or weld, structural parts of the building without the written authority of the ARCHITECT-ENGINEER. Welding to building structural steel, where authorized, shall be done by certified welders only.
3. Do not place flame producing equipment on any roof without the written authority of the OWNER.
4. Use concrete/masonry saws for cutting openings in existing concrete/masonry surfaces.

3.5 SUPPORTING ELEMENTS

A. General
   1. Provide all supporting elements, including supplementary structural steel and ancillary devices necessary to support the WORK, in accordance with specified and indicated requirements and applicable codes and standards.
   2. During construction and testing procedures, maintain the structural integrity of existing WORK by providing temporary shoring, bracing and reinforcing to safely support/restrain the live and dead loads imposed on the WORK by material, workmen, testing or inclement weather conditions.

B. Fastening To Building Structures
   1. The methods of attaching or fastening equipment or equipment supports or hangers to the building structure shall be subject to approval by OWNER'S REPRESENTATIVE at all times. Submit shop drawings or samples for approval before proceeding with the WORK.
   2. Cutting, burring, drilling, welding or the use of explosive driven fasteners on building structures shall require prior approval by OWNER'S REPRESENTATIVE for each type of application, unless specifically shown on the DRAWINGS.
   3. Equipment or piping shall not be attached to or supported from the roof deck, from removable or knockout panels, or temporary walls or partitions.

3.6 MAINTENANCE OF SURFACES/HOUSEKEEPING

A. Recondition or replace concrete which has not been adequately protected during pipe fabricating operations and which has become oil-soaked. Reconditioning entails putting concrete into a condition suitable for satisfactory adhesion of any specified surface finish. If concrete cannot be satisfactorily reconditioned, it shall be removed and replaced at no increase in CONTRACT Sum.

B. During the WORK maintain clean and safe WORK surfaces and housekeeping at minimum in compliance with NFPA-241. Upon completion of WORK in each respective area, clean and protect all WORK. Just prior to final acceptance of the project, clean finish all WORK to the satisfaction of the OWNER.

3.7 PAINTING AND FINISHING

A. Provide manufacturer's standard color finish paint system, on all equipment that has a published catalog finish, except as otherwise specified.

B. Bring all finished materials/equipment surfaces damaged prior to final acceptance to "as new" condition by touch-up, or replacement with original manufacturer's finish, including paint/coating/plating/galvanizing/high lustre polishing finishes.

C. Shop or field fabricated bare supplementary steel or metal fabrications shall have rough/sharp surfaces/edges removed, shall be thoroughly cleaned free of dirt, rust, oil, grease, weld slag, etc. and prime painted with (TYPE A or TYPE B) primer (specified under Division 09 Section "Painting.").

D. Field fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed, be thoroughly cleaned of dirt, rust, weld slag, grease or oil and prime painted with materials specified under Division 09 Section “Painting.”

E. Insulation system for piping, ducting and equipment surfaces may include an integral finish or a finish coating requiring no additional painting, except for specified identification.

F. Provide shop applied prime paint on all other mechanical equipment, compatible with specified finish, except as otherwise specified.

G. Finish painting, including all necessary prime painting of unpainted Division 15 Sections WORK surfaces is specified as part of the WORK of Division 09 Section “Painting,” unless otherwise specified.

3.8 LOCK-OUT AND TAG-OUT REQUIREMENTS

A. Submit LOCK-OUT AND TAG-OUT requirements drawings and instructions where pertinent to equipment installed under this CONTRACT.

3.9 MECHANICAL SYSTEMS IDENTIFICATION

A. General
   1. Provide a coordinated identification system which conforms to ANSI A13.1 and ANSI Z53.1 and which provides the specific colors specified herein. The system shall include:
      a. Framed and plastic protected diagrammatic layout of all systems, identifying and showing distribution elements, equipment, automatic or manual control location.
      b. Metal tag identified valves, systems components and equipment.
      c. Marked location of access doors.
      d. Marked location of mechanical systems controls.
      e. Color code and service identified piping and equipment.
      f. Color code and service identified air handling system ductwork and equipment.
   2. Apply the permanent mechanical systems identification work after completion of painting and finishing of the systems and components to be identified.
   3. Submit the entire identification system, including color codes, label legends and tag designations which are coordinated with the DRAWING nomenclature, for approval by the ARCHITECT-ENGINEER, prior to proceeding with the work.

B. Diagrams
   1. Diagrams shall be professional graphic drawings mounted in aluminum frames with 1/8 inch thick acrylic or polycarbonate plastic protection. Locate as directed by the ARCHITECT-ENGINEER. Provide one set of charts and diagrams for each mechanical equipment room except where additional charts and diagrams are required to define the systems. Where more than one chart per space is required, mount these in 170 degree pivot edge, swing leaf, extruded aluminum frame holders. Miller Multiplex Displays (800-325-3350) System 3000, 8000, or other approved.

2. List the equipment by CONTRACT DOCUMENT designation number, and show capacities such as flow rates, pressure and temperature differences, heating capacities, horsepower, voltage and current characteristics. This is required for such major equipment items as pumps, air handling system equipment, compressors, boilers, etc.

C. Metal Tags
   1. Provide all valves and equipment with corrosion resistant identification tags, minimum 2" diameter, brass, which can be easily read from floor level wired in place with No. 12 copper wire or equivalent brass chain and where applicable, give CONTRACT DOCUMENT equipment designation number. Wiring of tags shall be accomplished in a manner that will allow equipment operation thru normal cycles without removal of tag.
   2. Tags shall identify the following:
      a. Valve or equipment type (for example ball valve BA).
      b. Area (for example Bldg. 100A).
      c. Service (for example NPW).
      d. Series number (for example #1).
      e. Sample Tag: VBA NPW 100A-1.

D. Identification
   1. Locate legends and flow arrows in accordance with the following:
      a. Every 40 feet in straight runs.
      b. At each side of each building surface penetration.
      c. At branches and risers.
      d. At every sectionalizing or main shutoff valve.
      e. At each point where required to clearly identify system service.
      f. At each access door.
   2. Provide legend letters of the following heights:

O.D. or Straight Side of a Surface	Letter Height
Less than 1-1/2"	1/2"
1-1/2" to 4"	1"
More than 4"	2"

   3. When identification cannot be placed or retained on a surface for any reason, provide color coded double-faced sign panels supported from such surface by brass chain or by rigid means. Where one line is concealed from view by another, hang panels on lines to indicate location and direction of flow. Use 18 gage black sheet metal, 1/16" thick embossed aluminum, or 1/16" thick vacuum embossed plastic.
   4. Where normal flow is in one direction provide a single arrow. Where flow is normally reversible, provide double arrow.
   5. Where surfaces are adjacent to each other, line-up and locate legends to be visible from the floor. Make all legend outlines neat, free of fuzziness and other irregularities.
   6. Make stencils of corrosion resisting metal, and upon completion of the work, deliver full set of stencils to OWNER.
   7. Impregnated fabric or solid polyvinyl chloride plastic sheet, adhesive coated, commercially available identification legends are acceptable. Furnish materials suitable for continuous service at surface temperatures from -10 degF to 160 degF in relative humidities to 90 percent and for seasonal weather exposure without loss of attachment to surface being

identified. Should failure by loss of adhesion occur, repair contaminated surfaces and provide legend panels or stencil painted legends at no increase in the CONTRACT Sum.

a. Seton Name Plate Corp. “Snap-On”.
b. W.H. Brady Co.
c. Panduit Corp.
d. Markel.

3.10 CLEANING/PROCESS FLUID WASTE CONTROL

A. Process Fluids: All process fluids (chemicals), including cleaning solvents, shall be received, handled, stored, dispensed, utilized, and together with resultant waste, shall be disposed of in accordance with requirements of the Local Environmental Protection Authority and OWNER’S On-Site Chemical Coordinator, who shall be, sufficiently in advance of the WORK, advised of proposed activity, schedule, waste product concentrations and quantities, and furnished with Materials and Safety Data Sheets for each product involved.

B. Special care shall be exercised in handling/disposing of spills/wastes, to prevent injury to personnel, damage to facility/equipment, fire and pollution of environment.

C. Waste fluids shall be removed off-site to approved disposal facilities.

D. For materials which are disposed of off-site, provide the OWNER with paper audit trail and certification of disposal in accordance with the requirements specified and of authorities having jurisdiction.

3.11 FIELD QUALITY CONTROL

A. General
1. Prior to acceptance of the WORK, operate and test each completed system in conjunction with interfacing SECTIONS work, and in the presence of the Insurance Underwriters, and authorities having jurisdiction. Test systems per requirements of the local Fire Department, local Natural Gas Supplier, other applicable governing codes and the requirements specified herein. Provide all WORK materials, equipment and man power as required to properly execute each test.
2. Test Procedures: Develop the test procedures to demonstrate the satisfactory operation, within design intent, of each piece of equipment and each system. The test procedures, at minimum, shall be in compliance with the test procedures and methods recommended by the equipment suppliers/manufacturers. Submit the proposed test procedures to the OWNER/ARCHITECT-ENGINEER for review 30 days prior to start of testing.
3. Notify the OWNER/ARCHITECT-ENGINEER not less than ten working days prior to scheduled date of each test and request that a representative of the OWNER/ARCHITECT-ENGINEER witness each test.

B. Structural Integrity/Leak/Performance Acceptance/Miscellaneous Testing
1. Refer to Articles under the various Division 15 Sections, Division 13 Sections and Division 16 Sections for coordination and applicable requirements.

C. Noise Testing
   1. Refer to Division 13 Section “Noise Control” for applicable requirements.

D. Vibration Testing
   1. Refer to Articles under the various Division 15 Sections for applicable requirements.
   2. Refer to Division 13 Section “Vibration Control” for applicable requirements.

E. Systems Start-Up
   1. Adjust all parts of the various systems to function within the framework of design intent and operating characteristics specified or published by the equipment manufacturers. Bring into service condition all components, assemblies and systems prior to operation for any purpose, as required by the component, assembly or system manufacturer and the CONTRACT DOCUMENTS.
   2. In the event that temporary use of systems before all parts are complete is necessary and approved by the OWNER, adjust all parts to preclude damage and provide means to render temporary system use as effective as possible at no increase in CONTRACT Sum.
   3. Provide the services of an authorized technical representative of the manufacturer, satisfactory to the OWNER, in the event that the CONTRACTOR is unable to satisfactorily adjust any component, assembly or system and for OWNER’S personnel training. Arrangement for such services and costs thereof are to be borne by the CONTRACTOR.

F. Systems Operation Demonstration
   1. Calibrate and adjust, monitoring and control devices, accessories, equipment and components for stable and accurate operation to meet the design intent and to obtain optimum performance from each system. Final adjustment checking shall be performed while the systems are in full operation under load conditions. Cause every device to function manually and automatically, as intended, to insure its proper operation.
   2. After calibrations, adjustment, and checking have been completed and systems are operational, devise a program to demonstrate to the OWNER/ARCHITECT-ENGINEER and OWNER’S operating personnel the complete and correct functioning of all control systems and equipment in manual and fully automatic modes. These demonstrations shall consist of operating the controls through their normal full ranges and sequences. Simulate/induce, abnormal or emergency conditions to demonstrate proper functioning of safety devices or provisions. Readjust settings to their correct values and observe ability of systems to establish the desired conditions, noting abnormal deviations. Make necessary repairs, replacements or adjustments on items or systems which fail to perform satisfactorily and repeat tests to demonstrate compliance with the design intent. Demonstrate:
      a. Systems lock-out/tag-out provisions,
      b. Systems product delivery to point-of-use at specified/required quality, quantity, pressure,
      c. Proper control valve adjustment,
      d. Temperature control,
      e. Emergency liquid level control,
      f. Pressure control,

g. Taking portions of loops out-of-service, for local repair/change while maintaining remainder in service,
h. Sudden pump starts and stops or valve closure to simulate potential for system water hammer control response,
i. Simulate operation under part load, full load, detrimental conditions and determine system response.
j. Fail-safe crash due to loss of power or other utilities while in normal operation.
k. Compressed air pressure to operate valves at lower than design pressure.
l. Compliance with all other requirements to consistently deliver specified product/performance.

3. Notify the OWNER, sufficiently in advance of above scheduled WORK, so that the OWNER'S operating and maintenance personnel may be present for concurrent training purposes.
4. Upon satisfactory completion of each test, submit a written report to the OWNER/ARCHITECT-ENGINEER, including copies of test data to support the satisfactory completion, attesting to the adequacy and satisfactory performance of each piece of equipment and each system.
5. If testing indicates inadequacy of the equipment or the system, immediately notify the OWNER/ARCHITECT-ENGINEER and expedite the effecting of necessary change-outs or repairs to the equipment or to the system. After the equipment or the system has been corrected, retest the equipment or the system until satisfactory performance is demonstrated. Then comply with Paragraph 4 above.

3.12 SYSTEM OPERATION

A. Provide all necessary skilled staff and supervision man-hours to continuously operate and maintain systems during operation for CONTRACTOR'S convenience, and as required by the CONTRACT DOCUMENTS during systems start-up, check-out, adjustment/calibration, break-in, demonstration, performance testing, noise/vibration testing, acceptance testing, personnel training, and environmental conditions/concerns, and subsequently until final acceptance by the OWNER.

B. Equipment and systems shall be brought into proper operating condition prior to the operation of any equipment for any purpose or duration and subsequently, shall be put into appropriate and protective idle/standby condition on shut-down, in accordance with the requirements of the CONTRACT DOCUMENTS which includes all pertinent manufacturer's requirements and recommendations.

C. The cost of water, fuels and electricity supplied through OWNER'S meters will be borne by the OWNER.

3.13 FOLLOW-UP FIELD QUALITY CONTROL

A. Upon acceptance of the WORK by the OWNER, the guarantee period shall begin. At the same time, the OWNER will assume responsibility for operation and supply of expendables.

B. Approximately six months after the acceptance of the WORK, and while plant load is building up, the same field engineers who started the project systems shall return for at least two man-days of on-site observation, adjustment and supplementary training, for OWNER'S operating personnel. Upon completion of field work, the field engineers shall deliver to OWNER a comprehensive report as to WORK accomplished and/or WORK needed for the system to perform as required.

3.14 FIELD TESTS DURING GUARANTEE PERIOD

A. Testing to determine/verify compliance with requirements of CONTRACT DOCUMENTS shall be performed per the following:
   1. Test and testing procedures for items not delineated in CONTRACT DOCUMENTS, shall be mutually agreed upon, in writing, prior to start of testing.
   2. Specially requested test activity participant's costs shall be borne by:
      a. The OWNER if compliance is verified.
      b. The CONTRACTOR if testing indicates failure to comply.

B. Testing shall be performed in the presence of the OWNER'S REPRESENTATIVE.

C. If the testing or retesting of the WORK provided under this CONTRACT should indicate failure to meet the requirements of the CONTRACT DOCUMENTS, the CONTRACTOR shall be responsible for whatever addition, modification or replacements may be necessary to provide the OWNER with a system which fully conforms to these requirements. Repair work shall be scheduled at a time convenient to the facility being served.

3.15 TESTING SERVICES BY OWNER

A. The OWNER may employ the services of one or more testing agencies for the OWNER'S purposes, such as validating CONTRACTOR'S data. Any information or assistance furnished by these agencies shall not relieve the CONTRACTOR of his responsibility for his WORK and the rectification of any WORK which is not in compliance with the CONTRACT DOCUMENTS, without additional cost to the OWNER.

END OF SECTION

Revision History	
Date	**Rev. No.**
A	0
B	0
C	0
D	0
E	0
F	0
02-19-09	0

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